

REMARKS

The Specification has been amended to correct an obvious typo at page 9, line 5.

In the Claims, the preamble of claim 1 has been amended for clarification purposes.

Claim 1 has also been restricted to "single-phase" materials. Support for this amendment is found in our Specification, for example, at page 6, line 10.

Further, claim 1 has been restricted, to include the proviso that M is not solely Ni or Cr.

Claim 2 has been amended to remove the proviso, as redundant.

Claims 3 and 8 have been amended to include "Mg" in the list of "other metal cations". Support for this is found in our Specification e.g. at page 5, line 4..

Claim 6 has been amended to correct the obvious clerical error in the value of 'y' i.e. $0 < y < 1$ to agree with claim 1 and the Specification e.g. at page 4, line 5. Claim 6 has also been amended to include the proviso, as in amended claim 1.

Claim 6 has also been amended to include the voltage range as found in original claim 10(now cancelled), and a specific temperature range as found in our Specification e.g. in Examples 2 and 3.

Additionally, for clarification purposes, we have voluntarily amended the structural formula of the claimed materials in claims 1 and 6 to recite amounts of Li, Mn and M in terms of the variables x, y and z, respectively, based upon Tables 2 and 3. Similarly, in claim 6, the structural formula of the starting

materials now recites the amounts of Li, Mn and M in terms of the variable x , y and z , respectively. It is believed that since the amounts of Li, Mn and M are taken from Tables 2 and 3, or are based on values determined by single mathematical calculations, and attested to in the attached Declaration by Dr. Isobel Davidson, one of the inventors, that no "new matter" has been added.

New claims 11 to 17 have been added to further define our invention.

New claim 11 specifies the temperature as room temperature. Support for this claim is found in our Specification e.g. in Example 2.

New claims 12 and 13 specify the starting material e.g. in accordance with Figures 5 to 9 and Example 2.

New claim 14 specifies the material according to the invention e.g. as described in Tables 1 to 3 and in figures 4 to 12.

New claims 15 and 16 are directed to materials according to the invention, e.g. as described in Tables 1 to 3 and in figures 4 to 12.

New claim 17, is a process claim directed to more specific values of y , and is supported by Tables 2 and 3.

Claim Rejections 35 U.S.C. 102, 103(a)

Claims 1-10 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Kazuhara et al. JP 2001-023617.

The Japanese application describes the invention of a lithium secondary battery that includes an active electrode "material comprising a substance expressed in $\text{Li}_x\text{MnyM}_1\text{-yO}_2$ (M being one or more of Al, Fe, Co, Ni, Mg and

Cr, $0 < x \leq 1.1$, $0.5 \leq y \leq 1$). "During the manufacture process, the battery is charged at 4.0-4.8V at 60-80°C." Clearly the elevated temperature applied during charging in the manufacturing process plays a critical role in this invention. Furthermore, the Japanese reference in paragraph [0017] states that "if the temperature is less than 60°C, the potential maintenance neither increases the energy capacity nor improves rapid charge/discharge cycle characteristics."

Also, the Japanese reference states in paragraph [0035] that "it is preferable that the batteries be used at 60-85°C". In fact, all of the positive examples carry out the formation step at 70-80°C.

Also, conducting the formation step at 30°C did not provide a similar benefit (see example 12). Additionally, the benefit in storage capacity is only seen on cycling at elevated temperatures (50-75°C) in the case of the Japanese disclosure.

This teaches away from the low temperature process of amended claim 6, which now calls for a temperature range of room temperature to 55°C.

In the applicant's invention, the charging to form in-situ the materials of the invention is carried out at temperatures from "room temperature" (see example 2) to 55°C (see example 3). There is no need for high temperature heating to cause the changes in the active electrode material that result in the un-expectedly high reversible storage capacity of the materials according to our invention.

Additionally, in the Japanese application, charging to voltages as low as 4.0V is sufficient to produce the desired product. However, in our invention charging to higher voltages in the range of 4.4 to 5 volts is essential to form, by an in-situ reaction, the materials of the invention which have dramatically increased reversible storage capacity. In fact, materials made from the

same precursor composition charged in secondary cells to voltage limits in the range 4.0 to 4.3 volts do not show any enhancement in their reversible capacity. That said, in the actual examples in the Japanese reference the cells are all charged to 4.3 V in the formation process.

In the Japanese patent application, improved reversible capacities are only observed when the subsequently cycling is conducted at elevated temperatures of 50 -75°C. Comparison of examples 3 and 4 shows that the process of the invention does not improve the reversible capacities for cells cycled at ambient or even 30°C temperature. In our invention the active electrode materials show greatly enhanced reversible capacities at room temperature.

Accordingly, in order to further define our process claims over the prior art, we have amended claim 6 to include charging the cell to a voltage in the range of 4.4 to 5 volts, at a temperature in the range of room temperature to 55°C.

Regarding the product aspect of the invention, claims 1-4 are directed thereto. The Japanese patent describes the materials of their invention as being non-crystalline after the treatment procedure. However, the materials of our invention remain highly crystalline and retain their single-phase layered crystallographic structure.

More specifically, it is apparent from the end products that different processing results in differences in crystallinity and differences in room temperature cycling behaviour. Moreover, the material in the Japanese reference is said to be non-crystalline after processing (page 7 section 21 in translation). On the other hand, our materials are highly crystalline and maintain a single-phase layered crystallographic structure after the in-situ formation process. We did not include the crystallography data in the patent disclosure. We have however presented this in conferences, e.g. in the

publication entitled:

Published conference proceedings:

P. Whitfield, S. Niketic, Y. Le Page & I. Davidson, "Anisotropic Peak Broadening in $\text{Li}_{1.2}\text{Mn}_{0.4}\text{Ni}_{0.3}\text{Co}_{0.1}\text{O}_2$ Charged to High Voltages", Abstract #T5, pages 44-45, Programme & Extended Abstracts of the 3rd Lithium Battery Discussion, Bordeaux - Arcachon, France, 22-27 May 2005, as discussed in the attached 1.132 Declaration.

Consequently, it is evident that the materials in our invention are substantially different for the materials in the cited Japanese patent application.

For the sake of greater certainty, our claimed materials have been restricted by the proviso that M is not solely Ni (from original claim 2) or Cr.